

PAPER-III:
1230
ELECTRICITY AND MAGNETISM

UNIT – I

Electric Field: Coulomb's law, unit of charge (SI and other systems of units). Conservation and quantization of charge. Field due to different charge distributions, monopole, dipole, quadrupoles, line charge, sheet charge. Torque on a dipole in uniform field and non-uniform fields, flux of an electric field. Gauss's law - applications to deduce \mathbf{E} fields, force per unit area on the surface of a charged conductor.

Potential: Line integral of electric field and electrical potential. Field as the gradient of potential. Potential energy of a system of charges and its calculation in various configurations. Field equations for \mathbf{E} in vacuum. Energy associated with \mathbf{E} field. Differential form of Gauss's law: Poisson's equation, Laplace's equation, boundary conditions and uniqueness theorems.

Electric field around conductors: induced charges, field and potential inside a conductor, field near the surface of a conductor, method of images.

UNIT – II

Electric fields in matter: atomic and molecular dipoles, induced dipoles, electronic and molecular contributions. Electrical field caused by polarized matter, \mathbf{E} and \mathbf{D} fields, permittivity, dielectric constant. Capacitor filled with dielectric, field equations in presence of dielectric. The field of a polarized sphere, dielectric sphere in a uniform field. Energy in dielectric systems. Polarizability and susceptibility, frequency dependence of polarizability, Clausius-Mossotti equation.

Magnetic field: Magnetic field \mathbf{B} seen through Lorentz force on a moving charge, unit for \mathbf{B} field, magnetic dipoles in atoms and molecules, gyromagnetic ratio. Magnetic field due to currents: Biot and Savart's law. Field equations in magnetostatics, Ampere's law. Fields due to a straight wire, magnetic dipole, circular current and solenoid. Magnetic fields in matter. Magnetizing current, magnetization vector, \mathbf{H} and \mathbf{B} fields, magnetic permeability, susceptibility. Comparison of magnetostatics and electrostatics.

UNIT – III

Electrical current: current density and current; non-steady currents and continuity equations. Electrical conductivity, resistivity, conductance and their temperature dependence. Thermo electric current and dark current, non-ohmic circuitry, thermistor. Varying current. Rise and decay of currents in LR and CR circuits, time constant, integrating and differentiating circuits, electrical shielding. Study of a discrete LC transmission line.

UNIT – IV

Alternating currents: Skin effect for resistance at high frequencies, complex impedance, reactance, impedances of LCR series and parallel circuits, resonance, Q

factor, power dissipation and power factor. AC bridges: Anderson's, deSauty's and Owens bridges, Self and mutual inductance. Measurement of mutual inductance by Carry Foster Method, Coupled circuits and Transformers.

UNIT – V

Ballistic Galvanometer (moving coil type), its distinction from beat type. B.G. differential equation and its solution under different conditions of damping. Critical damping, over damping. Logarithmic decrements, charge sensitivity, current sensitivity, determination of B using search coil and B.G. Determination of high resistance using B.G. Factors for sensitivity. B.G. constant. Measurement of mutual inductance by Carey Foster's bridge by B.G. Measurement of small resistance by Kelvin's double bridge.

Recent developments in Physics including discussion of Nobel prizes in Physics (no questions to be set in the theory examination).

Text

1. A.S. Mahajan and A.A. Rangawala, Electricity and Magnetism, Tata McGraw Hill.
2. Electricity and Magnetism, P. Chakrabarty and K.C.Gupta, New Age International
3. Electricity and Magnetism (In Hindi) by Bhandari, Kalra and Kakani

Reference Books:

1. E.M. Purcell, Ed. Berkely Physics Course, Vol. 1, Electricity and Magnetism McGraw Hill.
2. D. Halliday and R. Resnick, Physics, vol. 2, Wiley Eastern, New Delhi.